

## TRAUMATIC DISLOCATION OF THE KNEE JOINT.

Of the three main etiological factors which may give rise to Dislocation of the Knee, viz:-

Congenital abnormalities,

Disease,

Traumatism,

I intend to limit myself to that of "Traumatism," which, although rare, is, in modern practice, probably more frequently met with than either of the other two.

Until comparatively recent years, "Disease," and more especially Tuberculous arthritis, was responsible for a very considerable number of cases which are happily now rarely met with, as a result of improved methods of treatment of that particular affection, either by palliative or by operative means.

With regard to Traumatic Dislocation itself, the literature on the subject is not very extensive, only some 114 cases having been collected by Stimson in 1901. Since his work appeared, I have been able to obtain particulars of five other cases in addition to the three which came under my own observation during the period I acted as House Surgeon at the David Lewis Northern Hospital, Liverpool.

As a general rule, the Surgeon or Practitioner

who may meet with a case records it in some form or another, but, even so, such Hospitals as exist mainly for the treatment of Accidents, comparatively frequently receive patients suffering from Traumatic dislocation of the knee, of which no record is kept beyond that in the books of the Hospital.

Such statistics as are available apparently point to the fact that Traumatic dislocation of the knee is of equal frequency with that of the hip, but such are evidently not trustworthy, as, unless presenting some unusual features, a case of Dislocation of the hip is unlikely to receive publicity; whereas it is more than probable that such would occur even with an uncomplicated Dislocation of the Knee.

Certainly, in the statistics prepared by Krowlein, they appear to be of almost equal frequency. He analysed the relative frequency of Dislocations of the various joints from the total number occurring in his Clinic, and found that, out of four hundred Dislocations, seven were of the Knee Joint and eight of the Hip. However, I am inclined to the belief that he had opportunities of observing a relatively large number of Knee cases compared to those of the Hip, due in all probability

to the fact that there are many Practitioners who would at once set about the reduction of a Dislocated Hip, but who would prefer to seek special advice where the Knee was the affected joint. That such a state of things should occur, is easily understood when one considers that the standard Text Books on Surgery deal much more fully with Dislocations of the Hip than with those of the Knee: and also that the visible deformity produced by the passage of the head of the femur out of the acetabular cavity is slight compared with the very evident anatomical disorganisation produced by an alteration of the normal positions of the Tibia and Femur respectively.

Lastly, it is by no means uncommon in Hospital practice to meet with old undiagnosed Dislocations of the Hip, a condition of affairs hardly conceivable in connection with the practically subcutaneous Knee Joint.

Taking the literature as it stands, I do not propose to analyse each individual case, but merely to bring prominently forward the main features both of the typical cases and of those which presented unusual features.

More especially do I wish to consider the anatomical details which have been recorded either by direct observation in the living subject through an



open wound or by dissection following amputation, and to contrast the results so obtained with those which I have myself obtained from a series of experiments upon the Joint itself.

So far as I have been able to ascertain, no previous research has been conducted upon this particular subject. What little I have been enabled to carry out is by no means complete, a misfortune due entirely to the very great difficulties experienced in endeavouring to obtain material upon which to work.

The demand for cadavera by the Anatomical and Surgical Schools leaves few at the disposal of those who wish to conduct research work, when such, as in this particular instance, involved the entire removal of the lower extremities for subsequent dissection and examination.

I have been enabled to experiment upon six bodies in all, and the results of this work will be indicated in detail at a later stage.

As the principle was very similar in all cases, a description of the method employed in general will be given here, any differences in individual cases being referred to subsequently.

When the body had been removed to the post mortem room, the required dislocation was produced by manipulation, with the aid of a single assistant,



either before rigor mortis had set in, or after it had passed off. This, in itself, was by no means so difficult as had been anticipated, and, with the exception of the "Internal" variety, was always accomplished without fracture of either Tibia or Femur.

The femoral artery was then exposed in Scarpas' triangle, a cannula inserted and tied in, the vein at the same time being ligatured. The other end of the cannula was connected, by means of a rubber tube, to a douche can containing a 33% solution of formalin. This douche can was raised to a height of two feet six inches from the limb, and the solution allowed to run into the artery.

The whole was then left for from twelve to sixteen hours, by which time the various structures were firmly <sup>hardened</sup> "in situ."

Any great excess of solution escaped into the abdominal veins by means of the sciatic and other veins, thus obviating any distension of the limb. At the end of the time stated, the cannula was removed, and in certain cases a weak solution of starch, containing red lead in suspension, was forcibly injected <sup>into the artery</sup> by means of a strong glass syringe.

At first this was carried out in all cases in order that the position of the various arteries

might be seen upon the subsequent skiagraph, but was discontinued when it was found that, owing to the rupture in <sup>producing the Dislocation</sup> ~~all cases~~ of a large number of small vessels in the vicinity of the joint, so much lead-containing solution escaped as to obliterate the outlines of the bones.

The limb was next removed from the trunk, and a skiagraph taken, after which the region of the knee joint was dissected according to a special plan by which only tendons, muscles and ligaments were retained, the dissection being then photographed as it stood. The utmost care was taken during the process of dissection to disturb the parts which were left as little as possible, in order that the resulting photographs might give a better conception of the actual condition of affairs brought about by the artificial dislocation. It was mainly with this object in view that only the above mentioned structures were retained, as it was recognised that any attempt to follow out the smaller nerves and vessels, and to expose them sufficiently to be seen in the photograph, would result in such a disturbance of the position of the larger structures as to make the photograph itself of little value as an attempt to reproduce the actual conditions of the structures intended.

With one exception, three photographs were obtained of each dissection, viz:- two lateral and one posterior.

During the process of dissection, careful notes were made, not only of the position and relations of the structures which were displayed upon the photographic plate, but also of the various structures which, from their anatomical situation, were unable to be represented owing to their deep seated and therefore concealed position. These notes will be considered in detail when the different forms of dislocation are studied seriatim.

#### ANATOMY OF THE KNEE JOINT.

I do not propose to append a detailed account of the normal anatomy of the joint such as is contained in any of the Standard Text Books on the subject, but merely to draw attention to the chief structures which are of importance from the point of view which I have selected, and to endeavour to explain their physiological significance in addition. With this object, I have prepared a limb in a manner similar to that previously mentioned, with the exception that it is a perfectly normal specimen. The subject was a muscular young farm labourer who was seized with appendicitis and died three days later from general suppurative peritonitis. The limb was extremely well developed, as is well shown



in the accompanying illustrations.

Fig. 2. indicates the appearances seen in a skiagraph of the region of the knee joint where the femoral artery had been previously injected with a solution containing red lead in suspension.

The remaining three Figs. (3,4 & 5.) show the appearances in a photograph of the same limb after dissection. Here I may state that, with one exception, all the limbs experimented upon have been reproduced in the same manner. The region of the knee joint may be looked upon as a triangular prism with blunted angles, the three surfaces being respectively Internal, External and Posterior; and an attempt has been made throughout to treat the subject upon this assumption.

Fig. 3. shows the Internal surface and the muscles and tendons which serve to support the joint upon that side. It will be noticed that the four inner hamstring tendons do not all occupy the same position in relation to the Internal Condyle.

The statement is unusually made that they all pass behind the condyle, but certainly in this particular instance both sartorius and gracilis lay upon its inner aspect, while the semimembranosus and semitendinosus were directly posterior to the



Fig II

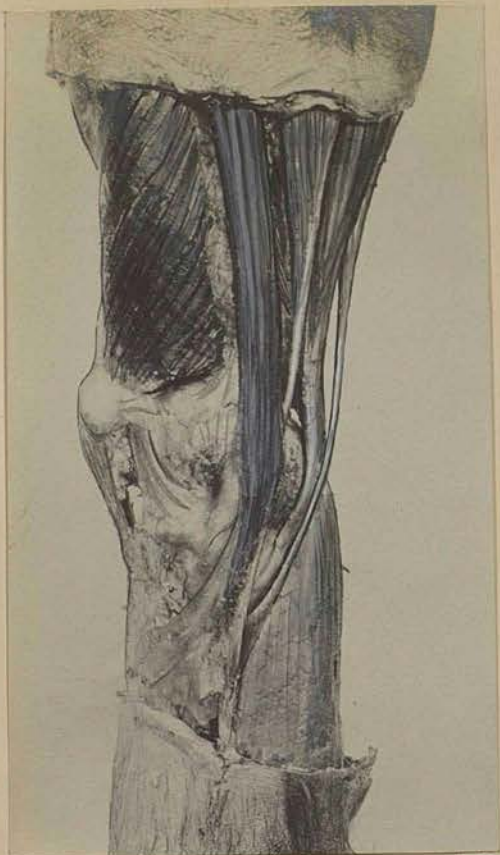


Fig III



Fig IV



Fig V



to the projecting bony condyle.

Whether the above is a more correct description of the relative relationships of these tendons or not I am unable to state definitely, but I am inclined to think that the accompanying illustration indicates a slight departure from the more common condition.

Fig. 4. shows the external surface with the Ilio-tibial band well marked. Although shown as a comparatively narrow band in the region of the joint, it is not by any means so definitely marked, the illustration only showing the strong central portion, whereas in reality it is more or less firmly attached to the outer side of the patella and ligamentum patellae, as well as to the popliteal fascia.

Fig. 5. shows the posterior surface, and here, in order to reproduce the outlines of the individual muscles, some little dissection was carried out both between semimembranosus and biceps above and between the two heads of the gastrocnemius below.

Passing to the more detailed consideration of the limb in the region of the knee, and regarding it as a triangular prism, the various structures which serve to keep the two articular surfaces in

apposition have now to be dealt with.

The anterior angle formed by the patella and ligamentum patellae is undoubtedly the strongest individual portion of the joint, neither structure having been seriously injured in any artificial dislocation, and only upon three occasions among the records of actual cases, and then only by direct violence.

The Internal surface, supported by the strong internal lateral ligament, which is directly attached to both femur and tibia in close proximity to the articular surface, is well provided for by muscles in addition. But it must be observed that the lower attachment of the internal lateral ligament is somewhat peculiar in that it is spread over a comparatively large portion of the inner surface of the shaft of the tibia, more especially anteriorly where it reaches downwards a short distance below the tibial tuberosity.

In addition, it is attached to the convex margin of the internal semilunar cartilage. A space is left in the intermediate area for the passage of the inferior internal articular vessels and nerve

Now it is quite possible to deprive this ligament of a considerable portion of its attachment without its receiving any apparent damage. Should its attachment to the internal semilunar cartilage and to the surface of the Tibia as far down as on a

level with the tuberosity be ruptured, the ligament as a whole would appear on superficial inspection to be apparently normal, and yet a very considerable range of lateral movement of the Tibia be permitted. Again, the central portion of the ligament itself is very considerably thickened; and this central band plays a prominent part when the experimental evidence is discussed. This inner surface of the joint area receives very powerful support from the inner hamstrings, viz: the sartorius, gracilis, semitendinosus and semimembranosus.

Whether they all pass behind the internal condyle or not, all but the semimembranosus turn well forwards, and are spread out over the tibial attachment of the internal lateral ligament before reaching their insertion.

The internal lateral angle is formed superficially by these hamstrings - or, perhaps, more correctly by the semimembranosus above - and by the inner head of the gastrocnemius below. More deeply is the short posterior portion of the internal lateral ligament, which extends only as far downwards as the insertion of the semimembranosus.

This latter muscle, close to its insertion, consists of both muscular and tendinous portions; the former being very easily ruptured in comparison with the latter.



Posteriorly the surface is made up of the semimembranosus and biceps above, with the two heads of the gastrocnemius below. Between these two sets of muscles are situated the great vessels and nerves whose presence is of very considerable importance owing to the frequency with which one or other are injured.

The posterior ligament is composed mainly of an expansion of the insertion of the semimembranosus, and is perhaps the weakest portion of the capsule.

The external lateral angle is formed superficially by the tendon of the biceps and the external popliteal nerve.

The external surface, as will be shown later, is undoubtedly the most powerful portion provided the anterior angle be provisionally excepted. It is only in this region that we have the capsule of the joint as a definite structure with a distinct ligament in addition. The cord-like long external lateral ligament, reaching from the external condyle to the styloid process of the fibula, gives very powerful support. In addition to this the tendon of the popliteus, the tendon of the biceps, and the strong ilio tibial band, which is practically the tendon of insertion of the tensor fasciae femoris, and greater portion of the gluteus maximus, add very considerably to the stability of the outer surface.

Besides these "external" structures, the Tibia and Femur are very firmly held together by means of the two crucial ligaments, which afford an amount of "internal" support unapproached by any other joint in the human body. Lastly the two semilunar cartilages, with the central spine of the Tibia, form a pair of sockets for the reception of the two condyles of the Femur.

In considering the knee joint as a whole, the capsule, apart altogether from the specially named ligaments, is of little importance as a supporting structure. It certainly exists upon the outer surface as a definite fibrous sheet thickened at one place to form the so-called short external lateral ligament, and also posteriorly both above and below the bandlike posterior ligament; but only in the former situation is it particularly evident.

As regards the anterior extremity and the internal surface of the limb, if the ligamentum patellae and the internal lateral ligament be removed, in addition to the bursa and pad of fat beneath the former, it is practically impossible to then separate a sheet of tissue distinct from the synovial membrane.

Physiology.

The bones entering into the formation of the knee joint are kept in apposition by means of the

ligaments and muscles as well as by the formation of the bony surfaces themselves, the pressure of the atmosphere - so important in the shoulder joint - taking little or no part.

Although the femur and tibia are alone directly concerned in the formation of the joint itself, yet the fibula is indirectly of some importance on account of the fact that the powerful long external lateral ligament and portions of the ilio tibial band and biceps are directly attached to its upper extremity.

However, as regards the stability of the joint, this fact may be discounted, as any upward pull upon the fibula is, owing to the direction of its superior articular surface, practically entirely transmitted to the tibia, only one case being mentioned in which dislocation was accompanied by a tearing off of the styloid process of the fibula.

There is no doubt that the position of greatest ease in any case of effusion into the joint is one of slight flexion, which, in other words, means the greatest amount of relaxation of the capsule, or, more, correctly of the lateral and posterior portions of the capsule, as it is obvious that the anterior portion, i.e. the ligamentum patellae, is in the condition of greatest relaxation in full extension.



*The former*

In ~~this~~ position, also, it is possible that the greatest amount of relaxation of the combined crucial ligaments takes place as in full extension; the anterior crucial is stretched to its utmost while the posterior is relaxed. If now the leg be slightly flexed, the anterior at once begins to relax, and relaxes considerably before tension is exerted upon the posterior, such being completed in full flexion when, in addition, the anterior becomes moderately tense.

In full extension the external lateral, as well as the posterior ligaments, are very tightly stretched but all become relaxed as soon as flexion commences.

From this it will be seen that the slight amount of rotation, of which the joint is capable, can only take place during flexion, and is perhaps best marked when the leg is flexed to a right angle.

Internal rotation is checked by the crucial ~~ii~~ ligaments, mainly by the anterior, and external rotation by the lateral ligaments, mainly by the internal. ~~flexion~~.

Flexion is limited only by the calf coming in contact with the thigh, but extension is limited by the posterior ligament as well as by the hamstrings.

An attempt to determine the effects produced by division of both crucial ligaments while the remaining structures which composed the joint were intact was made, but without any very definite results.

Subcutaneous, or practically subcutaneous, division of the crucial ligaments presents many ~~diff~~ difficulties but these were overcome in the following manner:-

The body, as soon as possible after death, was placed on a table, and the knee-joint freely moved so as to overcome any stiffness which might have been present.

A long, stout-handled needle, curved on the flat, was threaded with strong silk and passed into the joint cavity immediately to the outer side of the ligamentum patellae. The point was kept as close to the synovial membrane lining the outer portion of the capsule as possible, and gradually forced backward until it would go no further, when it was pushed through the capsule and brought out on the surface behind the tendon of the biceps.

The silk thread was then firmly held and the needle withdrawn.

This end of the silk was again threaded to the needle, which was reinserted through the same open-

ing behind the tendon of the biceps, and brought out on the inner side in front of the inner hamstring tendons.

The same manoeuvre was repeated, and the point of the needle still carrying the originally inserted end of the silk thread was brought out through the same opening to the outer side of the patella that it had previously entered.

The two crucial ligaments were now surrounded by the thread, little or no damage being done to any other structures.

To one end of the thread was now attached the end of a chain saw, which, by drawing on the thread, was made to surround the crucial ligaments. The chain saw was now drawn through, thus dividing the crucial ligaments alone. That these alone had been divided was subsequently proved by laying the joint freely open.

Division of the crucial ligaments in this manner produced remarkably slight results upon the joint as a whole.

Certainly it appeared to be as stable as before, and, beyond an apparent slight increase in the rotary movement when flexed to a right angle, no abnormal mobility was noted.

It appears, however, that after a time loss of function of one or other crucial ligaments so lessens



the stability of the joint as to render the limb practically useless for purposes of locomotion.

The strength of the knee joint and its comparative freedom from dislocation are matters of common consent, while no one would deny the frequency of fracture of the femur or tibia in its immediate vicinity.

Hence, a reason must be sought in order to endeavour to explain why the bones suffer so frequently while the joint itself as frequently escapes.

As before stated, the articular surfaces are retained in position by the action of muscles and ligaments in the main, but to some extent in addition by the shape of their respective surfaces. Now the relative rarity of dislocation compared to fracture in the vicinity seems to indicate that the Structures concerned in keeping the articular surfaces in apposition are, when acting in unison, more capable of resisting the incidence of violence than the bones themselves.

Experimentally, however, the converse appears to be the case, as in a total of eight attempts dislocation was produced in seven instances, and in only one was a bone, the femur, fractured. As both bones and ligaments are the same in the living subject and in the cadaver, the muscles alone are

left. These, from the manner in which they, or their tendons, are arranged round the joint, must by their tonicity alone exert a powerful influence in keeping the bony surfaces in apposition, and also by contraction materially aid the ligaments in withstanding shocks. In the cadaver, on the other hand, the muscles are simply lax, passive clothing, exerting no influence until overstretched. Hence, one is forced to the conclusion that, with regard to the knee joint itself, and to the bones entering into its formation, the normal joint is more able to resist violence, or, in other words, is stronger than bone, the increased strength being due to tonicity of the living muscle.

Against the <sup>arguments</sup>~~agreements~~ upon which this conclusion is based it might be urged that, in the series of experiments, dislocation alone and not fracture was aimed at; but, when using the tibia as a lever, with nothing but the hands of an assistant to control the femur, the niceties of pressure and leverage cannot be so adjusted that the maximum force has to be withstood by the muscles and ligaments of the joint and not by the bones in its immediate vicinity.

Case 1.

R. L., a strong healthy man aged 26 years, was admitted to the David Lewis Northern Hospital,

Liverpool, on May 8th, 1902. About fifteen minutes previous to admission, while engaged in his work in an Iron Foundry, he was struck on the left leg by a "bracket" of Iron weighing about 250 lbs., which fell from a height of six or seven feet. He was unable to rise, and was at once conveyed to the Hospital in the Horse Ambulance. On admission he was somewhat collapsed but perfectly conscious. The left Tibia was completely dislocated anteriorly, the posterior border of the tuberosities resting upon the anterior surface of the femoral condyles, which latter could be easily palpated, and formed a marked rounded prominence, in what should have been the hollow of the popliteal space. The patella was freely movable laterally, but had been rotated about a transverse axis so that the inferior extremity pointed forwards, and the posterior cartilaginous surface looked directly downwards and rested upon the upper articular surface of the tibia. Upon the inner side of the patella a vertical lacerated wound, one and a half inches long, penetrated the skin, but did not expose the deeper structures. Both the left tibia and fibula were transversely fractured about the middle of their respective shafts. Upon the sole of the left foot there was an extensive lacerated wound commencing one inch below the tip of the inter-



nal malleolus, and running directly forwards along the inner border of the foot to the metatarso-phalangeal joint of the great toe. From this point the wound ran outwards across the heads of all the metatarsal bones, and, on reaching the outer border of the foot, turned backwards along the fifth metatarsal as far as its base.

With the exception of the first, all the metatarsal bones were much comminuted, many fragments of bone being loose at the bottom of the wound.

Little or no ~~hemorrhage~~ had taken place from this wound; the leg itself was pallid, colder than its fellow of the opposite side, and no pulsation could be felt in either anterior or posterior tibial arteries. The region of the knee joint itself was considerably swollen, the bony structures alone admitting of definite palpation. The condition of the limb as a whole was such that I did not think any delay was justified, and therefore no skiagraph was obtained. Chloroform was at once administered, and the dislocation was reduced with the greatest ease, simply by traction upon the limb. Immediately the tibia had been replaced, the whole leg became flushed, pulsation could be easily felt in both anterior and posterior tibial arteries, and free

haemorrhage took place from the plantar wound.

This latter was packed with gauze and the limb steadied by means of sand bags placed on a pillow preparatory to a Choparts amputation, which was performed half an hour later. When the patient had been returned to bed, the limb was put up on a well padded posterior splint, so that the knee joint was slightly flexed and steadied by side splints.

No difficulty was experienced with regard to the fracture of the leg, but unfortunately the amputation wound became septic, and continued to discharge a large quantity of pus. This continued until July 18th, when the wound was enlarged, and several small pieces of necrosed bone removed, after which it rapidly healed, and the patient was discharged on August 30th.

As regards the treatment of the joint itself, it will be sufficient here to state that massage was commenced on the second day after admission, and passive movement at the end of a week, leaving further details, including the subsequent history, to be considered at a later stage.

Case 2. J. M., a carter, aged 52 years, was admitted to the David Lewis Northern Hospital, Liverpool, on September 22nd, 1902.

About ten minutes previously to admission, he was driving his cart in the street, he himself sitting on the shaft at its junction with the body. On jumping to the ground he slipped and fell, rolling over to his left side, clear of the wheels, which did not touch him. He was unable to rise, and was immediately brought to the Hospital in the Horse Ambulance.

On admission, the left knee was flexed to a right angle, and the whole leg rotated outwards through an angle of  $45^{\circ}$ .

The internal condyle of the femur projected sharply, and was covered by tense skin. The patella was firmly fixed, and lay to the outer side of the external condyle, rotated upon a longitudinal axis, so that the inner border looked forwards and the posterior cartilaginous surface inwards, resting upon and obscuring the outer surface of the external condyle. The internal tuberosity of the Tibia was very prominent, and immediately above it there was a marked hollow behind the external border of the patella.

The inferior surface of the external condyle was in contact with the upper surface of the internal tuberosity. Considerable effusion had taken place into the joint cavity. The lower end of the



Tibia was thickened as the result of a fracture which he had sustained fifteen years previously. A skiagraph was not obtained, as the Rontgen Ray apparatus was under repair at the time. Chloroform was administered, and reduction was easily effected on making sufficient traction upon the leg to free the spine of the Tibia, which had evidently been carried outwards so as to impinge against the outer surface of the external condyle. The limb was then put up on a well-padded posterior splint, with the knee-joint slightly flexed, and side splints applied to steady the whole limb.

Massage was commenced on the second and passive movement on the seventh day, by which time practically all the effusion had disappeared. Three weeks later the patient was discharged, with the limb enveloped in plaster of Paris.

Case 3. J. H., aged 30 years, was admitted to the David Lewis Northern Hospital, Liverpool, on December 26th, 1902.

A few minutes previous to admission, while walking in the street immediately in front of the Hospital in company with a friend -- both being under the influence of alcohol -- he suddenly felt his right leg give way under him, and he fell to the ground.

He was assisted to his feet by the bystanders, but fell again immediately on their support being withdrawn. He was then carried into the Hospital and was seen and examined by the Dresser, who sent for me, saying he had a case of dislocated knee in the Casualty Room. I at once went and examined the patient, and found apparently nothing beyond a very slight effusion into the knee joint. The Dresser persisted that the limb was not as it was when he first saw it, and proceeded to re-examine, when, to our surprise, the Tibia, without any undue force, was quietly and painlessly dislocated externally, by adduction of the foot. The external tuberosity of the Tibia then projected about one inch beyond the external condyle of the femur, limited to this amount apparently by the tendon of the biceps, and by the internal lateral ligament. The outer portion of the capsule and the long external lateral ligament were apparently completely ruptured. The internal condyle was then very prominent on the inner side, but the internal lateral ligament appeared to be intact on palpation.

The inner hamstring tendons were very tense behind the projecting internal condyle. The patella was freely moveable, and in its normal position between the two condyles; but the ligamentum patellæ was directed downwards and outwards. By



Fig i



simple replacement of the leg from its <sup>adducted</sup> ~~adapted~~ position the dislocation was reduced, and then the patient could fully flex the thigh with the leg extended, and from this position flex the knee to more than a right angle without assistance and without pain or discomfort. No history of any previous trouble in connection with the knee was obtained, nor was he sufficiently under the influence of alcohol to be insensitive to pain. He was at once taken to the Rontgen Ray Room, and the accompanying skiagraph (fig. I§) obtained.

Reduction was effected as easily as before, and the patient was put to bed and the whole limb enveloped in cotton wool, and a firm bandage, to prevent further effusion into the joint, in consequence of the repeated manipulation. The limb was then lightly bandaged to a long Liston's splint. The firm bandage was removed at the end of 24 hours, by which time all the effusion had practically disappeared, the limb put up on a well-padded posterior splint, with side splints in addition, and massage commenced. Passive movement was very cautiously undertaken on the seventh day.

The splints were kept on for three weeks, when the patient was discharged with the joint enveloped in a plaster of Paris casing. Three weeks later this was removed, and on examination the joint

appeared to be perfectly normal, and, from the patient's point of view, was perfectly sound.

#### VARIETIES of DISLOCATION.

The several forms of dislocation which have been described all refer to the position of the Tibia with regard to the Femur, and are :-

Anterior

Posterior

External

Internal

Rotatory.

Strictly speaking, few typical cases, with the single exception of the rotatory, occur, the majority being complicated with more or less rotation, and, even when such is absent, a purely antero-posterior or lateral is rarely seen, these being usually more or less combined, but nevertheless following in the main one or other form.

Again, any form may be "Complete" or "Incomplete," that is to say, the articular surfaces of the two bones may be entirely divorced or only partially so; in the latter case -- as in case 2 and case 3, before-mentioned -- two portions of articular surfaces, not normally in apposition, may be approximated to one another.

Finally, any form may be "simple" or "compound," although as yet no case of Compound Rotatory Dislocation has been recorded.

With regard to the Relative Frequency of each form, the following Table is appended, modified from the statistics collected by Stimson:-

TABLE.

	Simple	Compound	Total
Anterior	27.5%	17.5%	45%
Posterior	20%	9%	29%
External	16%	3%	19%
Internal	2.5%	1.5%	4%
Rotatory	2.5%		2.5%

It seems that the great preponderance of Antero-Posterior - 45% of all cases - is mainly due to the comparative weakness of the Posterior Ligament, and also to the fact that in the upright position the leg is fully extended upon the thigh. Any over extension - provided always that no solution of continuity of bone takes place - must, if considerable, result in rupture of the Posterior Ligament with, in addition, overstretching of the hamstrings and gastrocnemius, thus placing the Tibia in such a position that it may be easily dislocated in either an Anterior or Posterior direction.

Should the foot be firmly placed on the ground, and the ankle-joint fixed, anterior Dislocation of



the Tibia will result, while, in the event of the hip joint being fixed and force applied to the lower part of the leg or foot from behind, Posterior Dislocation will result. That the former of these two conditions is more likely to occur is sufficient to account for the relative frequency of the Anterior over the Posterior variety.

Direct violence either to Tibia or Femur, from the front or from behind, may easily produce an Antero-posterior Dislocation; but there is no reason to assume that such may occur more frequently in one situation than in another.

As regards the relative infrequency of the lateral Varieties, there are here two factors at work.

Firstly, the very great strength of the ligaments and tendons upon the lateral aspects of the joint, which, in contradistinction to the strong anterior ligament, allow of no lateral movement whatever with the exception of a very slight amount in the flexed position: and, secondly, that owing to the position of the other limb direct violence to the inner side of the Tibia and Femur must be an extremely rare occurrence.

That the External is more common than the Internal is due chiefly to the fact that, in falling from a height, one tends to fall to the outer side rather than to the inner in cases where one foot

reaches the ground first. To this fact is due the great frequency of Pott's fracture of the lower end of the Fibula. As a rule, when falling in this manner, the knee is "fixed" but, should the ankle be "fixed" and the muscles round the knee-joint be taken unawares, the individual will still tend to fall over to the outer side, with the result that he sustains an External Dislocation of the Tibia. As typical instances of this manner of falling, reference may be made to Case 2 and to Case 3.

A note may here be made of the fact that the accepted nomenclature which considers the position of the Tibia alone is hardly correct when, for example, the term "External Dislocation of the Knee Joint" is applied to a condition brought about by Internal Displacement of the Femur as a result of either direct or indirect violence .

Such anomalies occur with every variety of Dislocation, and should be borne in mind.

In so far as the Rotatory Form is concerned, this subject has been fully worked out, and will be further considered at a later stage.

It is interesting to note, in conclusion, that Percival Pott (1726) makes no mention of the subject of Dislocation of the Knee in his book, from which one may safely assume that he had never met with a case.

The individual Dislocations will now be considered separately as regards mainly their anatomical features.

Anterior Dislocation. In this variety the plane of the Tibia lies Anterior to its normal position, and may vary from the comparatively slight amount shown in figure 6 to the complete displacement indicated in Figure 10.

It would appear from the anatomical facts to be shortly brought forward that in the vast majority of cases there is rupture of

- a. Posterior Ligament.
- b. Crucial Ligaments.
- c. Greater part of both Lateral Ligaments with, in addition, partial rupture and overstretching of the Hamstrings and Gastrocnemii, and Plantaris, and some stretching of the Popliteal vessels.

A remarkable exception has been recorded by Desormeaux, where, in a case of Incomplete Anterior Dislocation upon which an autopsy was performed, the only lesion present was Incomplete Rupture of the Anterior Crucial Ligament. The only possible explanation, upon anatomical grounds, of such a condition of affairs is that not only was the actual displacement slight, but the patient must have had either very long or very easily stretched Ligaments. Certainly experimental evidence by no means supports



the view that the above is anything but an extreme coincidence.

A much more typical case has been recorded by Annandale in which, to quote his own words, "the Quadriceps Extensor tendon and Ligament of the patella were intact; there was a triangular-shaped and lacerated wound of the capsular Ligament on the inner aspect of the joint. The rent measured two inches in the longitudinal direction, and one inch and a quarter transversely, and was situated about half an inch above the upper border of the patella. On reflecting the patella and its ligament so as to open into the joint the crucial, internal, and external lateral ligaments were seen to be completely torn across, the crucial and other ligaments being severed from their femoral attachments. The semi-lunar cartilages remained in their normal position, and the connections of the gastrocnemius muscle to the femur were not altered. Some extravasated blood lay external to the muscles of the calf, between the deep fascia and subcutaneous tissue; but there were no signs of any special effusion of blood. Posteriorly the capsular ligament was torn across in its whole extent ..... The inner coat of the Popliteal artery was ruptured about  $1\frac{1}{2}$  inches above its bifurcation, and there clotting had taken place."

The two skiagraphs of artificially produced anterior Dislocation, one incomplete, figure 6, and the other complete, figure 10, show very clearly the amount of bony displacement, while the detailed description of the condition of affairs seen upon subsequent dissection, of which ~~x~~ illustrations are produced, will be found to be very closely approximate to that of the natural Dislocation so carefully described.

Throughout the entire series of experiments, certain structures were found to be lax, and appeared slightly wrinkled when hardened in formalin. In the natural condition this would be entirely obliterated, in so far as muscles and tendons were concerned, by the tonic contraction of the muscles themselves.

#### INCOMPLETE ANTERIOR DISLOCATION.

Vide Figures VI, VII, VIII  
and IX.

The Skiagraph (Fig.VI) shows the position of the bones in an artificial incomplete Anterior Dislocation. In this no attempt was made as in some of the others to inject the vessels, as several specimens had been spoiled in attempting to do so. Those injected were done at a more recent date, when the method had been so far improved as to



Fig VII





Fig VII



Fig VIII



Fig IX

allow of the main vessels being injected, the force being graduated so that little entered the smaller vessels, so many of which had been ruptured in the production of the particular Dislocation.

Anterior. The Quadriceps Extensor Muscle was lax and wrinkled, while the Anterior Surface of the Patella looked upwards as well as forwards.

Internal. (Fig. VII) The greater part of the Internal Lateral Ligament was ruptured, but the strong central band was intact, as well as the portion of the Ligament in front of it. The Sartorius was intact, but was spread out upon the inner surface of the femoral condyle; while immediately behind the muscle were the tendons of the gracilis, semitendinosus, and semimembranosus.

External. (Fig. VIII) The Biceps and Iliotibial band, with the external Popliteal Nerve, lay upon the outer aspect of the external condyle, and were all intact, although the nerve was very tightly stretched. The outer head of the gastrocnemius, with the plantaris, were carried outwards on to the external surface of the condyle but were intact; as were also the entire external portion of the capsule including both external lateral ligaments.

Posterior. (Fig. IX) The muscular portion of the semimembranosus was entirely ruptured, but



the tendon, as before stated, lay to the inner side of the femoral condyle. The inner head of the gastrocnemius was entirely ruptured, while the Popliteal Artery and vein, with the Internal popliteal nerve, were stretched over the external condyle. The lumen of both vessels was occluded, and on opening them the coats of the Artery appeared to be normal, but the inner coat of the vein was slightly torn transversely. The Posterior Ligament was entirely ruptured.

On opening the joint both Crucial Ligaments were completely torn from their femoral attachments, and the external semilunar cartilage, although firmly attached at both ends, had been torn from the Tibia round the convexity of its margin. The Popliteus tendon was ruptured close to its attachment to the femur, but the tendon sheath was intact.

The remaining structures in the interior of the joint, including the delicate Ligamentum Mucosum, were normal.

#### Complete Anterior Dislocation.

The skiagraph shown in Fig. X represents a further stage of displacement than that in Fig. VI. The Tibia is seen to be over-riding the femur for nearly an inch, and the patella is rotated to a considerable extent.





Fig X



Fig XI



Fig XII

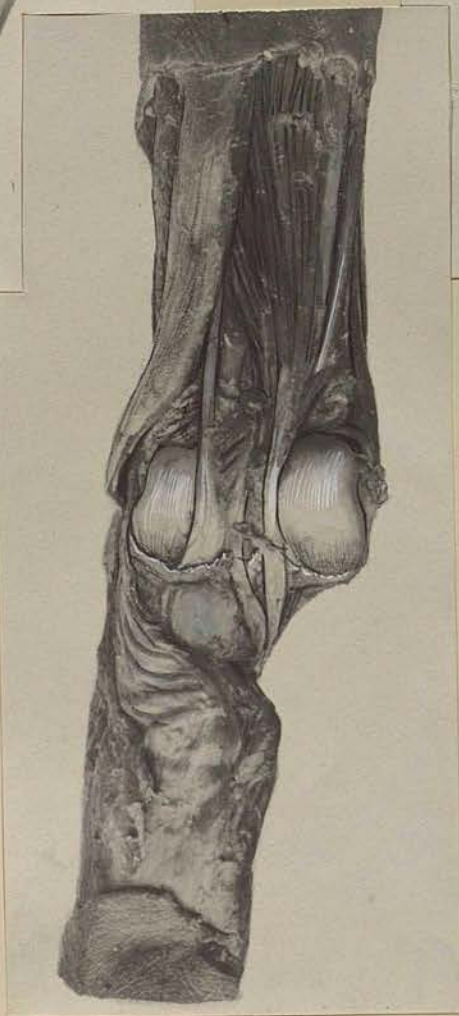


Fig XIII

Anterior. The Quadriceps extensor muscle was lax and wrinkled, and the patella looked upwards as well as forwards.

Internal. (Fig. XI) The Sartorius muscle was very conspicuous as a muscular band spread out over the Internal Surface of the condyle, below which the tendon rejoined the inner hamstrings and passed almost directly forwards to its insertion into the Tibia. The Internal Lateral Ligament was only partially ruptured, the strong central band and all the Ligamentous fibres in front of it being intact.

External (Fig. XII). The Biceps and Ilio-Tibial Band were intact, the lower ends of both passing almost directly forwards to their respective attachments. The external head of the Gastrocnemius and a very well marked Plantaris were intact, but lay on the outer side of the External Condyle.

The entire External portion of the capsule, including both External Lateral Ligaments, were unruptured. The External Popliteal nerve had been ruptured at the point where it wound round the neck of the Fibula.

Posterior. (Fig. XIII). Both Femoral Condyles were markedly prominent, the Hamstring Tendons with the Popliteal Vessels lying in the Intercon-



dyllar notch, where the combined pressure of these structures had entirely obliterated the lumen of the Vessels. Both gracilis and semitendinosus were intact, but the muscular portion of the Semimembranosus was ruptured. The tendinous portions of this latter muscle was tightly stretched but intact and passed round the lower end of the Femur and then turned forwards and slightly upwards to its insertion. All the muscular fibres in the origin of the outer head of the Gastrocnemius were torn from their Femoral Attachment, but the tendinous fibres were intact and occupied the intercondylar notch with the other tendons and vessels above mentioned.

The Internal Popliteal Nerve was intact, but the entire Posterior Ligament was ruptured.

On opening the joint the Popliteus tendon was found to be detached from its origin, but the sheath of the tendon remained uninjured. The Anterior Crucial Ligament was torn from its femoral, and the Posterior from its Tibial attachment.

The remaining structures, including both semilunar Cartilages, appeared to be quite normal.

From the appearance of Fig. XIII, it would seem that the Tibia had been displaced laterally as well as Anteriorly, but this was not the case, and is in reality due to the marked projection of the femoral

condyles combined with some rotation of the entire specimen while the photograph was being taken, so that the result is not a direct Posterior view of the dissected specimen.

#### POSTERIOR DISLOCATION.

This, though not so common as the Anterior variety, is, according to the Statistics previously given, more frequently met with than the lateral. Should the displacement backwards of the Tibia be such as to cause a complete Dislocation, it seems that of necessity both the Posterior and the whole or part of both Lateral Ligaments must rupture; and, in addition, certain of the muscles which pass behind the point must be severely damaged.

The crucial Ligaments are usually ruptured entirely.

However slight the displacement, the Posterior Ligament is always ruptured, and many muscular fibres torn.

I have been unable to find any record of a complete dissection of a Posterior Dislocation, but several have been referred to by various Authors without their authorities being quoted. In one case, which will be subsequently referred to more fully when the question of treatment is discussed,



Fig XIV





Fig XV



Fig XVI



Fig XVII

Spence was forced to open the joint in order to effect reduction, and noted then that the Internal Lateral Ligament was ruptured and the Posterior part of the left Semilunar Cartilage was displaced. It is unfortunate that the Artificial Posterior Dislocation to be immediately described cannot be directly compared with a similar condition which had actually occurred.

Posterior. The Skiagraph shown in Fig. XIV is that of an Incomplete Posterior Dislocation artificially produced. A small amount of injection has entered the Popliteal Artery, the line of which, with one or two branches, is faintly indicated. The position of the various structures will be more fully indicated in detail below.

Anterior. The Quadriceps Extensor was slightly stretched, but intact, over the lower end of the femur, and the Anterior Surface of the patella looked directly downwards.

Internal. (Fig. XV) The Inner Hamstring tendons all lay on a plane posterior to the Internal Condyle, part of which was exposed owing to rupture of the posterior portion of the Internal Lateral Ligament. The anterior portion of this Ligament was separated from its upper attachment but remained in apposition with the Condyle owing to the fibrous connections between it and the tendon of the Vastus Internus.



External. Fig. XVI. The Biceps was very tightly stretched round the External condyle, but was intact, as were also the Ilio-Tibial band and the External Popliteal nerve. A small portion of capsule posteriorly was ruptured, but the External Lateral Ligaments were both unruptured.

Posterior. Fig. XVII. All the Hamstring tendons were very lax and wrinkled. In Figs. XV. and XVII it would appear as if the Semitendinosus muscle were ruptured high up, but it had merely become detached from under the thin strip of skin which should have held it in position.

The entire inner head of the Gastrocnemius was torn from the Femur, but both the outer head and the Plantaris, though very tense, were intact, as were also the Popliteal Vessels and the Internal Popliteal Nerve. The former (as seen in Fig. IV) were separated by a considerable space from the Popliteal surface of the Femur, and the Lumen of each was occluded as the vessel passed over the projecting rim of the Tibial Tuberosities. The Posterior Ligament was entirely ruptured.

On opening the Joint the Posterior Crucial Ligament was seen to be torn from its Femoral, and the Anterior from its Tibial attachment. The ligamentum mucosum was ruptured, but the tendon of the



Popliteus as well as the Semilunar Cartilages were uninjured.

#### EXTERNAL DISLOCATION.

This, the more common Lateral Displacement, does not present so great a variety as the other forms, and is also more liable to occur to a slight extent than either of the two Antero-posterior Varieties. If the Dislocation be incomplete, it may be limited by either the Internal or the Long External Lateral Ligament, one side remaining intact in either case. If Complete, both lateral portions of the Capsule are ruptured, together with the Crucial ligaments. These latter may partially or wholly rupture even when the outward displacement of the Tibia is slight. In addition the Gastrocnemius almost always, and usually the Biceps, are very considerably damaged.

It is, however, the comparative frequency with which the External Popliteal Nerve is ruptured that constitutes the additional gravity to this particular Dislocation.

A very complete account of the anatomy of an actual case has been given by Poland, in which the conditions found nine days after the injury was received are minutely recorded:

"There was a large rent on the outer side of the joint. The skin and fascial tissues, separated from the outer tuberosity of the Tibia, formed a cavity full of blood. The outer head of the gastrocnemius was much lacerated anteriorly at the level of the head of the Tibia, and just below this the outer part of the Soleus was in the same condition. At the same level the Popliteus was torn right through. The Ligament connecting the Tibia and Fibula, being completely divided, allowed the head of the Fibula to be slightly displaced forwards.

The Styloid process of the latter bone was broken off and drawn upwards by the External Lateral Ligaments.

The fascial structures on the outer side of the joint were extensively lacerated, and all the tissues, including the Coronary Ligament, were stripped from the outer tuberosity of the Tibia, thereby leaving the External Articular Fibro-Cartilage almost free in the joint, the Posterior Attachment of the Cartilage being also separated. Both the Crucial and the Posterior Ligaments were torn off, the former from their upper and the latter from its lower attachment, as far as the Posterior limb of the Internal Lateral Ligament, which was intact.

The External Popliteal Nerve was torn across and detached from the main trunk in the upper part of the Popliteal space. The Popliteal Artery and vein were uninjured. The joint contained some blood, and its synovial membrane was swollen and inflamed."

The opposite condition as regards the Lateral Ligaments was present in the case recorded by Hargreaves, in which :-

"The Internal Lateral Ligament was completely ruptured, and the External only partially torn. The Anterior Crucial Ligament was torn across, but the Posterior Crucial and the Ligamentum Patellae were intact."

Fig. XVIII shows a Skiagraph of an Incomplete Artificial External Dislocation, in which the External Lateral Ligament is intact. Of the other hand, if this Skiagraph be compared with Fig. I, it will at once be noticed that in the latter the opposite condition was obviously present. It is apparently more common to find the External Lateral Ligament intact, the reason for which I will attempt to explain later, when the mode of production is discussed.

Dissection.      Anterior.      The Patella occupied its normal condition, a faint outline of which is seen in Fig. XVIII.





Fig XVIII



Fig XIX



Fig XX



Fig XXI

Internal. (Fig. XIX). The Inner Hamstrings were in their normal position and intact. The entire Internal Lateral Ligament was ruptured, but the strong central band stood out markedly and appears in the illustration to be intact, the rupture having taken place at its Femoral Attachment, with little or no displacement of the Band.

External. (Fig. XX). On this aspect the whole of the various tissues were intact.

Posterior. (Fig. XXI). The Posterior Ligament was ruptured, as well as a few of the deeper fibres of the Gastrocnemius, chiefly those belonging to the Inner Head, but all the remaining structures were intact.

On opening the joint both Crucial Ligaments were found to be torn from their Femoral Attachments, and the Internal Semilunar Cartilage was loosened but not free.

The specimen from which these photographs were taken, as well as that of the Incomplete Anterior Dislocation (Figs. VII, VIII and IX), differed from the others in that it was removed subcutaneously after having been hardened in formalin, so necessitating the encircling Ligature to prevent the various structures from being displaced during dissection.



### INTERNAL DISLOCATIONS.

This variety is extremely rare, and the proportion of Compound to Simple Cases is very great, extreme violence being necessary to produce the condition.

During the series of experiments which were carried out, the only case of Fracture (of the Femur) was produced in attempting to dislocate the Tibia inwards.

Eventually the required displacement was effected, but not before the Long External Lateral Ligament had been subcutaneously divided.

Again, only two photographs of the subsequent dissection have been reproduced, as the third negative was unfortunately broken after the specimens had been destroyed.

The anatomical details seen in actual cases were mainly observed in Compound Dislocations before Reduction was effected. In one instance the External Condyle of the Femur presented through a wound in the skin three inches in length, the External Lateral Ligament being entirely ruptured.

In a second instance the soft parts covering the External Condyle were extensively torn, as well as the Posterior Ligament and the Gastrocnemius.



Fig XXII

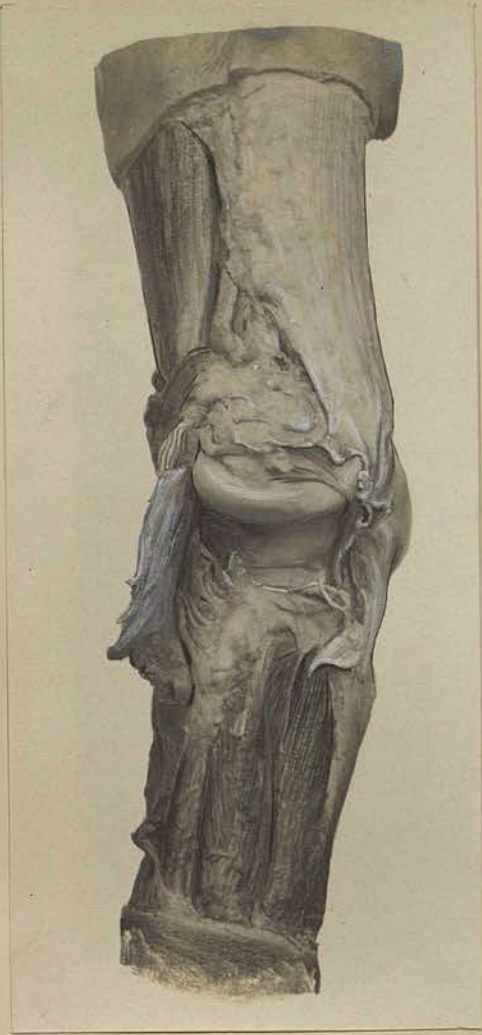


Fig XXIII



Fig XXIV



In the skiagraph (Fig. XXII) of an Artificial Incomplete Internal Dislocation, in which the arteries are seen to be injected, the outlines of the bones are much obscured owing to the injection escaping into the tissues from a large number of small vessels, the Popliteal Artery itself being uninjured.

Dissection.    Anterior.    The Patella and Ligamentum Patellae were intact, the former lying on the Internal Condyle.

Internal.    All the structures on the inner aspect of the joint were intact, but the Internal Lateral Ligament was very tightly stretched, limiting the displacement of the Tibia.

External.    (Fig. XXIII).    The External Lateral Ligament had been cut across while the entire remaining portion of the Capsule on the outer side was ruptured.    The Biceps tendon had passed behind the Condyle, and a portion of the Ilio-Tibial band was torn, but the greater part remained intact.    The Popliteus Tendon, with its sheath, was completely detached from its origin from the Femur.

Posterior.    (Fig. XXIV).    The entire outer head of the Gastrocnemius, as well as the Plantaris, were torn across a short distance below their origin.    The Posterior Ligament was wholly ruptured.

The remaining structures on this surface were intact, but carried inwards by the Tibia.

On opening the Joint the two Crucial Ligaments were found to be ruptured, the Anterior from its Tibial and the Posterior from its Femoral attachment.

The convex margin of the External Semilunar Cartilage was detached from the Tibia, but both ends remained attached. The Ligamentum Mucosum was ruptured, but the Internal Semilunar Cartilage was intact.

#### ROTATORY DISLOCATION

Rotation of the Tibia, apart from that usually met with in one of the other forms of Dislocation, is excessively rare, but the following varieties have been recorded.

- a. Rotation about a longitudinal axis passing through the Spine of the Tibia.
- b. Rotation about a longitudinal axis passing through the centre of one or other tuberosity.

In the former variety both tuberosities would be separated from their corresponding Condyles, but in the latter that tuberosity through which the axis of rotation passed would remain in contact with

the corresponding Condyle, while the other would be more or less dislocated in either an Anterior or a Posterior direction.

The first case of Rotation of the Tibia, unaccompanied by any other displacement, was recorded by Dubreuil and Martellièrre in 1852, and these observers conducted a series of experiments upon the Cadaver in which a similar condition was produced, the limbs being subsequently dissected. Their results were fully recorded in the "Archives Général de Médecin, 1852, Vol. XXX, p.p. 150 and 288"

Subsequently Sulzenbacher confirmed these experiments (Wiener Med. Presse 1880 Vol. XXI, p. 272), and I do not propose to enter into the subject other than to state that in all the cases Reduction by reverse Rotation was easy, and the subsequent results were good, neither the great vessels nor nerves having been seriously injured in any instance.



### ETIOLOGY and MECHANISM.

As the scope of this work is limited to "traumatism," consideration of the Etiology of Dislocation is thus narrowed down to the question of Direct, as against Indirect, violence. This question is by no means easy to answer in individual cases, as even where a full history is available, it is often impossible to arrive at a definite conclusion as to which form of violence was the immediate etiological factor.

As an instance of this, case 1. may be taken, and the salient features repeated. The man was standing watching a heavy piece of iron being hoisted by a crane. This weight thus suspended struck by one end against the wall, breaking the wire rope by which it was held; the <sup>other</sup> ~~other~~ end striking in its fall the patient's left leg.

The multiplicity of his injuries, viz., dislocated knee, fractured tibia and fibula and compound fractured metatarsus, are difficult to follow out, but the presence of the wound beside the patella made it appear as if the Dislocation itself was caused by direct violence, the femur being driven backwards.

At the same time there is no proof that the above is the correct explanation, which might possibly be

that the iron merely grazed the knee, the greater part of the violence being received by the foot and the remaining injuries caused by the resulting fall.

Neither the explanation of the patient himself, nor of those who witnessed the accident, were of any value in aiding settlement of the question.

Again in many cases the history is either absent or so slight as to afford no information concerning the actual form of violence.

In Case II and Case III it is evident that both were the result of indirect violence, as each was due to a fall wherein the absence of bruising or laceration was conspicuous.

It may here be mentioned that several authorities have suggested that a previous attack of Syphilis predisposes to Dislocation, by weakening the various ligaments; but the evidence upon which such a statement has been made does not appear to be at all clear.

Mechanism.

As any form of Dislocation of the knee may be due to displacement either of the Femur or of the Tibia, these will have to be considered separately.

The mechanism when Direct violence is the cause may be dismissed in a few words as such can hardly be said to exist when the end of a bone, to which violence is applied, is thereby forced into an abnormal situation. It is here a question simply of the

degree of violence, the displacement, and the accompanying tissue damage, varying directly as the force.

#### Indirect Violence.

Here the question of leverage is all important, the displaced end of the bone being more or less remotely removed from the point which receives the impact.

#### Anterior Dislocation.

When caused by a fall with the foot planted firmly on the ground and the ankle fixed, the trunk carrying with it the upper part of the femur passes forwards. The lower end of the femur passes backwards, the axis of rotation being a transverse line through the femoral attachments of the lateral ligaments, these acting as the fulcrum. The posterior ligament always, and the two crucial ligaments almost always, rupture. In many cases also the lateral ligaments partially or wholly rupture at the end of the movement, but it would appear that this is not entirely necessary, as a slight amount of stretching on their part would allow the articular surfaces of Femur and Tibia to become dissociated.

Finally the limb is straightened by contraction of the **Quadriceps Extensor** and **Gastrocnemius**, and, should the dislocation be complete, the Tibia may, by the same muscles be pulled so far upwards as to



overlap the lower three inches of the femur as happened in a case reported by Annandale.

It would appear from the experimental evidence that any unruptured muscles or portions of muscle tend to pass into the intercondylar notch, and rarely to be diverted to the lateral aspects of the femur.

When the Tibia itself is actually displaced, the mechanism is very similar with the exception that the axis of rotation passes through the tibial and fibular attachments of the lateral ligaments.

Such a state of affairs is brought about when - as in Haycock's case - a man became entangled by his arms in a piece of machinery by which he was revolved three or four times. At each revolution the lower part of the anterior aspect of the leg and the dorsum of the foot struck against the roof of the building. Here the axis of rotation must have been situated close to the upper end of the Tibia, as the double Dislocation which resulted was not compound.

Posterior Dislocation. The mechanism of this variety is very similar to the Anterior, except that the hamstring muscles are the active agents by which the bones are fixed in their abnormal positions, with or without over-riding.

The ligamentum, patellae with the patella, is pulled backwards over the lower articular surface of

the femur and is tightly stretched; but has been known to rupture in only a single instance.

Lateral. The two lateral forms may be taken together, as the mechanism is the same, whether the result be Internal or External Dislocation. Here one lateral ligament is first ruptured following which one or both crucial ligaments give way. The opposite lateral ligament does not necessarily rupture unless the Dislocation be "Complete" in which case this must certainly result.

The rotation which so frequently accompanies Lateral Dislocation is due partly to the action of gravity, owing to which the limb is carried in one or other direction - usually outwards - and partly to the fact that the muscles upon one side are commonly less injured than those on the other side

#### DIAGNOSIS.

This may in the vast majority of cases be summed in the expression "Self Evident," but it is with regard to the remaining few cases that some little care is necessary.

Very rarely does the knee become dislocated before the age of twenty years, by which time the lower Epiphysis of the Tibia should have united.

As such, however, has occurred (Kronlien) it is

important to definitely palpate the lines of the knee joint in every case of suspected separation of either of these two Epiphyses, of which separation of the femoral is by no means uncommon. I have myself seen separations of the femoral epiphysis which closely simulated both Anterior-posterior and Lateral Dislocations.

Fracture of either Femur or Tibia in the vicinity of, but not implicating the joint, could hardly be mistaken for Dislocation.

When the joint itself is involved, as in the so-called T. shaped fracture of the femoral condyles or where one or other Tuberosity of the Tibia has been broken off, there is always present a certain slight degree of Dislocation, but such is wholly subservient to the fracture, and cannot be compared with the definite Dislocation of the ankle joint associated with a severe Potts Fracture of the Fibula.

As a rule the amount of effusion into the joint is not very considerable, and pain is by no means a marked feature.

In any case of doubt a Skiagraph, or even the use of the fluorescent screen with the X Rays, will at once settle the question.



## PROGNOSIS.

In an uncomplicated case the Prognosis is undoubtedly very good provided reduction be effected without operative interference.

As Sir Astley Cooper says -

"The first case of this kind (i.e. Dislocation) which I witnessed was brought to St. Thomas' Hospital whilst I was an Apprentice there, and I remember being struck with three circumstances in it. The first was the great deformity of the knee from the projection of the Tibia. The second was the ease with which the bone was reduced by direct extension, and the third the little inflammation which followed upon what appeared to be so serious an injury, for the man was discharged from the Hospital in a few weeks having suffered little local or no constitutional irritation."

The patient in favourable circumstances may resume his ordinary employment in from six to eight weeks from the receipt of the injury.

Where the actual Dislocation is complicated by such as fracture of the Tibia, or Femur, or by rupture of one of the Popliteal vessels or nerves the condition is much more grave.

In the former condition convalescence will be prolonged, with perhaps some degree of permanent partial disablement; while in the latter considerable permanent disablement is practically certain to result.

Again, a fracture in the vicinity of the knee joint may very seriously impede reduction of the Dislocation.

The Popliteal Artery or vein may be torn across so calling for immediate amputation, or the inner coat alone of either vessel may be ruptured, thus leading to Thrombosis and Amputation, when, after reduction, all seemed well.

The External Popliteal nerve has been several times ruptured, but, so far as I am aware, not the Internal. The results of suturing the divided nerve have been by no means satisfactory, "drop foot" usually persisting to a greater or less extent.

When the joint, or it may be the fracture, communicates with the Exterior by an open wound, the dangers of "Sepsis" are added.

Excluding rupture of the inner coat of the vessels, a more definite Prognosis may be given when Reduction has been effected. This in itself may even require operative interference for its accomplishment.

Frequently the Popliteal vessels and nerves are so compressed as to lead to the suspicion that one or other of them has been ruptured, but such would be dispelled on careful examination after the deformity had been reduced.

Taking into account the various complications, it may be stated as a general rule, that, where pulsation returns in the Anterior and Posterior Tibial Arteries after Reduction an attempt should be made to

save the limb.

Should an aukylosed joint be the best result obtained, that in itself is preferable to an artificial limb; while should the patient recover, with a weakened joint this may possibly be rectified by operative means which fall short of producing a permanent aukylosis, such for instance as suture of one or other Lateral or even of the Crucial Ligaments.

#### TREATMENT.

It will simplify matters if consideration of the Treatment to be adopted in an uncomplicated case be first undertaken, following which the several complications will be treated seriatim.

The first essential is to reduce the Dislocation, and this, more especially in Antero-Posterior cases is often a matter of urgency owing to pressure upon the Popliteal vessels.

In almost all cases - Case III being a notable exception - Chloroform should be administered, not only to relax the muscles and so aid in the Reduction, but also to allow of a special examination, so far as possible, of the structures surrounding the joint, where such an examination without an anaesthetic would give rise to considerable pain.

As a rule Reduction is extremely easy, simple Traction perhaps combined with ~~Flexion~~ Flexion being sufficient to allow of the two bones resuming



their normal position. It has been stated that Reduction, especially in Incomplete Lateral cases, may be impeded owing to the Spine of the Tibia impinging against the External or Internal surface of the Femur. This does not appear to be the true explanation, as it seems more probable that the condition is brought about by incomplete rupture of one Lateral Ligament. When reduced the limb must be steadied by some form of splint, which is not only comfortable from the Patient's point of view, but allows of some degree of relaxation of the various Ligaments.

Undoubtedly the best position is that of slight Flexion whereby the leg forms an angle of about  $150^{\circ}$  with the thigh. The Lateral, Posterior and Crucial Ligaments are then collectively more relaxed than in any other position, thus favouring their ultimate union should all or any of them have been ruptured.

To obtain this a "Macintyres" splint is convenient but I prefer an ordinary back splint with a foot piece, to which a suitable pad of wool has been firmly fixed by means of a flannel or flannelette bandage.

The foot is then fixed to the foot piece by means of a few turns of a figure-of-eight and finally side splints serve to steady the whole, especially in Lateral Dislocations, retained by a couple of straps or slip-knots.

This form of splint constitutes a firm but comfortable bed upon which the limb rests, and allows of the site of the injury being easily exposed for massage or examination, without in any way disturbing the limb as a whole.

Early massage, commencing from twenty-four to forty-eight hours after receipt of the injury, is of great relief to the patient, hastens absorption of effused products and prevents muscular waste; and should therefore be employed in all cases except perhaps in those where the presence of a large wound calls for as little interference as possible until all danger of sepsis has disappeared.

Passive movement should be commenced about the end of the first week, by which time all effusion should have disappeared. These movements should be carried out with the greatest care, and for the first few days should not consist of more than gentle flexion and extension, the leg being slightly raised from the splint with one hand while the other steadies the thigh which should not be allowed to move at all.

Although passive movement in the early stage has only been comparatively recently adopted in the treatment of injuries in the neighbourhood of joints, it is interesting in this connection to quote Sir Astley Cooper, who, in 1829, said that the best result he had

seen in the case of Dislocated knee was that of a Posterior Dislocation in which passive movement was commenced on the fourteenth day.

By the end of the third week from the receipt of the injury flexion to a right angle should be reached, by which time, if necessary, the limb may be enveloped in Plaster of Paris or Water Glass in the extended position, from a short distance below the great trochanter to the foot and the patient allowed to go home.

It is better to fix the ankle, as if this is not done the weight of the dressing is apt to force the lower edge on to the malleoli and dorsum of the foot, so setting up ulceration of the skin.

The Plaster or Water Glass should be left on for three to four weeks and then removed. The patient should within <sup>ten to fourteen days</sup> ~~a few~~ be able to resume work, but, if possible, he should not at once attempt a full day, but should preferably confine himself to light or part time work for ten or fourteen days.

Of the many complications which require special attention one of the most difficult, but happily uncommon, is that of inability to effect Reduction.

This may be due to fracture of the Tibia in the immediate vicinity to the formation of adhesions, owing to the time that has elapsed before a Medical man was consulted; or possibly to certain muscles and Ligaments having been stretched but not actually



ruptured at the time the injury was inflicted, their recoil strongly inhibiting Reduction. Apparently to this latter cause was due the difficulty experienced by Spence in attempting to reduce an incomplete Posterior Dislocation in a Miner, aged 50 years. Failure attended all except the last of the following series :-

1. Manipulation under chloroform.
2. Continuous extension by means of a weight of sixteen pounds for three days.
3. Further manipulation under chloroform.
4. Extension by pulleys, using all justifiable force.
5. Finally an incision was made and the unruptured external Lateral Ligament and hamstring tendons were divided, when Reduction was easily effected.

When the above is compared with the ease with which case III was reduced and reproduced, the extent to which individual cases may differ is very forcibly brought out.

An old standing Dislocation may require excision of the Femoral Condyles, as has been done on several occasions, before Reduction can be effected, although this should never be undertaken until manipulation under deep Chloroform Anaesthesia has failed after having been repeated at least on two or three occasions.

Slight wounds in the vicinity of the joint, not rendering the Dislocation Compound, should be very

carefully cleansed with some Antiseptic lotion, and thoroughly drained to obviate all chance of infection being carried to the deeper structures and possibly into the severely damaged joint cavity.

When the Dislocation has been rendered Compound this is usually due to either the Femur or the Tibia-almost invariably the former - having been forced through the skin from within, the wound in the skin being large and ragged. the condition not only as regards the limb but also as regards the life of the patient is very serious and active Antiseptic measures have to be taken to endeavour to render the wound aseptic before Reduction is effected. attempted. It is difficult to draw any hard and fast rule as to when to amputate at once, experience being by far the best guide. Certainly the limb will have to be sacrificed immediately should either the Popliteal Popliteal artery or vein be found to be torn, on direct inspection through the wound, but should these be seen or felt to be intact an effort should be made to save the limb, as even as early as 1825, long before the introduction of antiseptics, successful cases were recorded where either the Femur or the Tibia projected through the wound. Where the wound is posterior some form of interrupted splint such as those in use for excision of the knee joint will be required in order to

allow of free access and drainage. Fracture not implicating the joint is usually of the Tibia and is by no means an uncommon occurrence. The fragments are as a rule easily brought into apposition and retained by the same splint or splints as used when such complication is absent.

Should retention of the fragments be difficult on no account should extension be employed as in one such case recorded case recorded the ultimate result was good in so far as the fracture was concerned, but union of the Lateral and Crucial Ligaments was interfered with to such an extent that the patient recovered with a "flail" joint rendering the limb useless for purposes of locomotion. In such a case it would have been better to have exposed the fracture by open incision and wired or



screwed the bones into position. The analogy of the shoulder joint where the fracture is allowed to unite and then the Dislocation reduced, would be impossible in regard to the knee where reduction of an old standing Dislocation has never been successfully carried out by manipulative means.

Where the fracture is originally compound much saving of time and a better ultimate result would be attained by immediate wiring or screwing.

Recovery sometimes takes place with a "flail" joint and should this be the case the Ligaments at fault should be determined, cut down upon and united by sutures.

Mayo Robson has successfully sutured the crucial ligaments under these circumstances, with excellent results.

As previously stated rupture of either or both popliteal vessels will necessitate amputation, as even if the vein alone be injured gangrene of the limb is practically certain to result, should the more immediate danger of haemorrhage be successfully combated.

Rarely the inner coat alone of the artery has been ruptured, the resulting thrombosis requiring amputation a few days later. It is not possible to diagnose such a condition until thrombosis has stopped the circulation in the limb, collateral circulation being

prevented by the rupture of numerous small vessels surrounding the joint at the time the initial injury was received.

Even without rupture of the arterial wall Aneurism may supervene some months later, but by this time a collateral circulation will have been sufficiently established to permit of ligation of the femoral artery.

Of the nervous complications by far the most important is Primary rupture of the External Popliteal nerve, which has occurred on several occasions. Suture of the divided ends either at once or within three weeks has not given good results. The nerve itself may be ruptured high up in the Popliteal space or as it winds round the neck of the Fibula, so that difficulty may be experienced in securing the divided ends.

Should paralysis of the Peroneal group of muscles persist, the patient may get about fairly well in some form of apparatus, in which the place of the paralysed muscles is taken by an elastic band.

Whether due to partial rupture or to injury, trophic ulcers of the nature of "Perforating Ulcer of the Foot" sometimes occur, and these are very intractable. Healing may occasionally be brought about by avoiding the pressure of ill-fitting boots after the ulcer has been very freely scraped.

After History. In any disease or injury the After History of the case is usually the most difficult period concerning which reliable information is obtained. If all is well at the end of a few months the patient will not take the trouble to report himself, while on the other hand if he is not satisfied with his condition he more often than not consults another Medical man, or attends a different Hospital.

Again, attempts to find old patients are often unavailing, owing to their having removed either from the district or the town without leaving any trace of their whereabouts behind them.

Of the three cases I have seen I succeeded in finding and examining two of them in February, 1905.

Of these, case I was seen two years and nine months, and case II two years and two months after their respective injuries had been received, but no trace whatsoever could be obtained of case III.

Case I. The patient was wearing a "stump" boot laced up to the middle of the calf. He was in constant employment as caretaker of a Church-yard, his actual work consisting mainly of digging. He stated that he could walk and work as well as he could before his foot was amputated.

He had changed his work from that of a labourer in an Iron Foundry, simply because there was no vacancy for him in the Foundry, and he was compelled



to accept the first offer that allowed of him supporting his wife and family.

On examination the stump was found to be soundly healed, and no signs of pressure sores could be made out. The joint where the Tibia and Fibula had been fractured could not definitely be made out, the anterior border of the Tibia being quite uniform. The scar on the inner side of the Patella was visible, but the movements of the knee joint were perfectly normal, nor could any abnormal movements be obtained. Without effort he was able to bring the heel to within three inches of the buttock; the limb as a whole was well developed but appeared to be slightly less so than its fellow, from below the knee.

Case II. Recovery in this case had been complete in the best sense of the word. The patient had returned to his former employment - that of a carter - two months after the accident was sustained, and had been at work without interruption and without inconvenience since that time.

Beyond the thickening of the lower end of the Tibia the limb was perfectly normal, as were also the movements of the knee joint. He stated that following the fracture which had taken place seventeen years ago he had lost some of the "springyness" of his foot, but this had in no way been increased by the subsequent injury to the knee.

His complete recovery is all the more remarkable considering his age, and the heavy nature of the work that he is called upon to perform.

Very few cases have been followed after having once left the direct control of the Surgeon, but Maylard saw a case of Incomplete Internal Dislocation twenty-three weeks after the injury was sustained when "he was walking perfectly well and stated that he felt as sound upon his limb as he did prior to the accident."

Another Incomplete External Dislocation with rotation of the Patella was shown at a meeting of the New York Medical Society three years and a half after the accident, when "the function of the knee was perfect and the muscular development of the leg was normal."

Recovery to the extent of flexion of the leg to a right angle without lateral movement was noted by Adams six months after the injury was received.

This case was very similar to Case I as in addition to complete Posterior Dislocation there was present a Comminuted fracture of both bones of the leg in the upper third, with a cutaneous wound which did not communicate either with the fracture or the Dislocation.

In conclusion, from a careful survey of the entire subject, it seems that provided the great vessels and nerves be uninjured, complete recovery may confidently

be expected. On the other hand a nervous lesion will probably result in more or less permanent disablement while a vascular lesion practically means amputation, either immediate or within a few days.

To the above general statement must be added a word with regard to the possibility of sepsis occurring in compound cases.

Much will depend upon whether this can be avoided by antiseptic treatment, and if successful no untoward result should be anticipated. Should sepsis unfortunately supervene then the result, if amputation can be avoided, will be one of considerable limitation of normal movement, if not of absolute immobility.

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